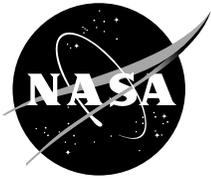


NASA/TM—2000–209891, Vol. 214



**Technical Report Series on the  
Boreal Ecosystem-Atmosphere Study (BOREAS)**

*Forrest G. Hall and David E. Knapp, Editors*

**Volume 214  
BOREAS TF-11 SSA-Fen 1995  
Leaf Area Index Data**

*T.J. Arkebauer*

National Aeronautics and  
Space Administration

**Goddard Space Flight Center**  
Greenbelt, Maryland 20771

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November 2000

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**BOREAS TF-11 SSA-Fen 1995  
Leaf Area Index Data**

*Timothy J. Arkebauer  
University of Nebraska-Lincoln*

National Aeronautics and  
Space Administration

**Goddard Space Flight Center**  
Greenbelt, Maryland 20771

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November 2000

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# BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data

Timothy J. Arkebauer

## Summary

The BOREAS TF-11 team gathered a variety of data to complement its tower flux measurements collected at the SSA-Fen site. These data are LAI measurements made by the TF-11 team throughout the 1995 growing season. The data include the LAI of plants that fall into six categories: total, *Carex* spp., *Betula pumila*, *Menyanthes trifoliata*, *Salix* spp., and other vascular plants. The data are stored in tabular ASCII files.

## Table of Contents

- 1) Data Set Overview
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- 20) Document Information

## 1. Data Set Overview

### 1.1 Data Set Identification

BOREAS TF-11 SSA-Fen 1995 Leaf Area Index Data

### 1.2 Data Set Introduction

These data are Leaf Area Index (LAI) measurements made by the Tower Flux (TF)-11 team at the BOREal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA)-Fen site throughout the 1995 growing season. These data include the LAI of plants that fall into six categories: total, *Carex* spp., *Betula pumila*, *Menyanthes trifoliata*, *Salix* spp., and other vascular plants.

### 1.3 Objective/Purpose

The objective of this study was to quantify the distribution of green LAI during the growing season for the various plant species in the SSA-Fen.

## **1.4 Summary of Parameters**

Each data record includes the date and the LAI in each of six categories: total, Carex spp., Betula pumila, Menyanthes trifoliata, Salix spp., and other vascular plants.

## **1.5 Discussion**

The overall project goal was to investigate the surface-atmosphere exchange of carbon dioxide and methane, and the associated energy fluxes at the SSA-Fen site. The LAI data were collected in support of the various components of the overall project.

## **1.6 Related Data Sets**

BOREAS TF-11 SSA-Fen Tower Flux and Meteorological Data  
BOREAS TF-11 SSA-Fen 1996 Water Surface Film Capping Data  
BOREAS TF-11 SSA-Fen Leaf Gas Exchange Data  
BOREAS TF-11 SSA-Fen Soil Surface CO<sub>2</sub> Flux Data

## **2. Investigator(s)**

### **2.1 Investigator(s) Name and Title**

Dr. Timothy J. Arkebauer, Associate Professor  
Department of Agronomy  
University of Nebraska-Lincoln

Dr. Shashi B. Verma, Professor  
Department of Agricultural Meteorology  
University of Nebraska-Lincoln

### **2.2 Title of Investigation**

Field Micrometeorological Measurements, Process-Level Studies and Modeling of Methane and Carbon Dioxide Fluxes in a Boreal Wetland Ecosystem (SSA-Fen)

### **2.3 Contact Information**

#### **Contact 1:**

Dr. Timothy J. Arkebauer  
Department of Agronomy  
106 KCR Building  
University of Nebraska  
Lincoln, NE 68583-0817 USA  
(402) 472-2847  
(402) 472-3654 (fax)  
tja@unlinfo.unl.edu

#### **Contact 2:**

David Knapp  
Raytheon ITSS  
NASA GSFC  
Code 923  
Greenbelt, MD 20771  
(301) 286-1424  
(301) 286-0239 (fax)  
David.Knapp@gsfc.nasa.gov

### **3. Theory of Measurements**

LAI is the total leaf area per unit ground area. For broadleaf species, the leaf area is taken as one half the total surface area of the leaf, i.e., the area projected normal to the plane of the leaf.

### **4. Equipment**

#### **4.1 Instrument Description**

A LI-COR LI-3100 leaf area meter was used to determine the leaf area of the samples.

##### **4.1.1 Collection Environment**

Samples were collected at the SSA-Fen site in ambient conditions from May to September 1995.

##### **4.1.2 Source/Platform**

None given.

##### **4.1.3 Source/Platform Mission Objectives**

None given.

##### **4.1.4 Key Variables**

Date, LAI for the following categories: total vascular plants, *Carex* spp., *Betula pumila*, *Menyanthes trifoliata*, *Salix* spp., and other vascular plants.

##### **4.1.5 Principles of Operation**

None given.

##### **4.1.6 Sensor/Instrument Measurement Geometry**

None given.

##### **4.1.7 Manufacturer of Instrument**

LI-COR, Inc.  
P.O. Box 4425  
4421 Superior Street  
Lincoln, NE 68504 USA  
(402) 467-3576  
(402) 467-2819 (fax)

#### **4.2 Calibration**

None given.

##### **4.2.1 Specifications**

The LI-3100 was operated and maintained in accordance with the manufacturer's instructions.

###### **4.2.1.1 Tolerance**

None given.

###### **4.2.2 Frequency of Calibration**

None given.

###### **4.2.3 Other Calibration Information**

None.

## 5. Data Acquisition Methods

A sampling area was chosen that had vegetation characteristics similar to the eddy correlation instrumentation "footprint." This area was located several hundred meters south of the main eddy correlation boardwalk.

A transect approximately 200 m long was laid out in an east-west direction. The transect was divided into four 50-m-long subtransects, giving a total of 20 samples. On each sampling date, five locations were chosen at random along each of the four subtransects giving a total of 20 samples. All the vegetation above the surface of a 0.25 m<sup>2</sup> area at each location was harvested. Samples were placed in plastic ziplock bags and transported to the leaf area meter.

For each sample, green leaves were separated from stems and dead material. Leaf area of each of the following categories was determined: *Carex* spp., *Betula pumila*, *Menyanthes trifoliata*, *Salix* spp., and other vascular plants.

## 6. Observations

### 6.1 Data Notes

None.

### 6.2 Field Notes

A limited set of field notes and observations is available by request from T.J. Arkebauer (see Section 2.3).

## 7. Data Description

### 7.1 Spatial Characteristics

#### 7.1.1 Spatial Coverage

All of the data were collected in the vicinity of the SSA-Fen flux tower site. This tower is located at the following North American Datum of 1983 (NAD83) coordinates:

Latitude	Longitude	BOREAS_X	BOREAS_Y	UTM Northing	UTM Easting
53.80206°N	104.61798°W	419.527	330.991	5961566.6	525159.8

#### 7.1.2 Spatial Coverage Map

None given.

#### 7.1.3 Spatial Resolution

Each sample was from a 0.25 m<sup>2</sup> area. There were 20 samples for each day on which measurements were taken. See Section 5 for details.

#### 7.1.4 Projection

None given.

#### 7.1.5 Grid Description

None given.

### 7.2 Temporal Characteristics

### 7.2.1 Temporal Coverage

Measurements were made on 20-May, 02-Jun, 22-Jun, 28-Jul, 17-Aug, 08-Sep, and 29-Sep-1995.

### 7.2.2 Temporal Coverage Map

None.

### 7.2.3 Temporal Resolution

These data were collected on particular days. See Section 7.2.1.

## 7.3 Data Characteristics

### 7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
MEAN_TOTAL_LAI
STD_ERR_TOTAL_LAI
SEDGE_LAI
BOGBIRCH_LAI
MENYANTHES_LAI
SALIX_LAI
OTHER_LAI
CRTFCN_CODE
REVISION_DATE

### 7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
MEAN_TOTAL_LAI	The total vascular plant mean green Leaf Area Index (mean of 20 samples).
STD_ERR_TOTAL_LAI	The standard error of the total vascular plant mean green Leaf Area Index.
SEDGE_LAI	The Leaf Area Index for all Carex species.

BOGBIRCH_LAI	The Leaf Area Index of Betula Pumila.
MENYANTHES_LAI	The Leaf Area Index for Menyanthes trifoliata.
SALIX_LAI	The Leaf Area Index for Salix species.
OTHER_LAI	The Leaf Area Index for all other vascular plant species.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

### 7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
MEAN_TOTAL_LAI	[unitless]
STD_ERR_TOTAL_LAI	[unitless]
SEDGE_LAI	[unitless]
BOGBIRCH_LAI	[unitless]
MENYANTHES_LAI	[unitless]
SALIX_LAI	[unitless]
OTHER_LAI	[unitless]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

### 7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS.]
SUB_SITE	[Assigned by BORIS.]
DATE_OBS	[Supplied by Investigator.]
MEAN_TOTAL_LAI	[Supplied by Investigator.]
STD_ERR_TOTAL_LAI	[Supplied by Investigator.]
SEDGE_LAI	[Supplied by Investigator.]
BOGBIRCH_LAI	[Supplied by Investigator.]
MENYANTHES_LAI	[Supplied by Investigator.]
SALIX_LAI	[Supplied by Investigator.]
OTHER_LAI	[Supplied by Investigator.]
CRTFCN_CODE	[Assigned by BORIS.]
REVISION_DATE	[Assigned by BORIS.]

### 7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	SSA-FEN-FLXTR	SSA-FEN-FLXTR	None	None	None	None
SUB_SITE	9TF11-LAI01	9TF11-LAI01	None	None	None	None
DATE_OBS	20-MAY-95	29-SEP-95	None	None	None	None
MEAN_TOTAL_LAI	.088	1.281	None	None	None	None
STD_ERR_TOTAL_LAI	.016	.083	None	None	None	None
SEDGE_LAI	.041	.286	None	None	None	None
BOGBIRCH_LAI	0	.346	None	None	None	None
MENYANTHES_LAI	0	.409	None	None	None	None
SALIX_LAI	.001	.153	None	None	None	None
OTHER_LAI	.017	.152	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	29-MAR-99	29-MAR-99	None	None	None	None

Minimum Data Value -- The minimum value found in the column.

Maximum Data Value -- The maximum value found in the column.

Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined that the parameter value was below the detection limit of the instrumentation.

Data Not Cllctd -- This value indicates that no attempt was made to determine the parameter value. This usually indicates that BORIS combined several similar but not identical data sets into the same data base table but this particular science team did not measure that parameter.

Blank -- Indicates that blank spaces are used to denote that type of value.

N/A -- Indicates that the value is not applicable to the respective column.

None -- Indicates that no values of that sort were found in the column.

### 7.4 Sample Data Record

The following are wrapped versions of data records from a sample data file on the CD-ROM.

```
SITE_NAME , SUB_SITE , DATE_OBS , MEAN_TOTAL_LAI , STD_ERR_TOTAL_LAI , SEDGE_LAI ,
BOGBIRCH_LAI , MENYANTHES_LAI , SALIX_LAI , OTHER_LAI , CRTFCN_CODE , REVISION_DATE
' SSA-FEN-FLXTR ' , ' 9TF11-LAI01 ' , 20-MAY-95 , .088 , .016 , .041 , .001 , 0.0 , .011 , .036 , ' CPI ' ,
29-MAR-99
' SSA-FEN-FLXTR ' , ' 9TF11-LAI01 ' , 02-JUN-95 , .471 , .051 , .114 , .208 , .054 , .077 , .017 , ' CPI ' ,
29-MAR-99
```

## **8. Data Organization**

### **8.1 Data Granularity**

The smallest amount of data that can be ordered from this data set is the entire set of data.

### **8.2 Data Format**

The Compact Disk-Read-Only Memory (CD-ROM) files contain American Standard Code for Information Interchange (ASCII) numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

## **9. Data Manipulations**

### **9.1 Formulae**

None given.

#### **9.1.1 Derivation Techniques and Algorithms**

None.

### **9.2 Data Processing Sequence**

None given.

#### **9.2.1 Processing Steps**

- The BOREAS Information System (BORIS) received data from TF-11.
- BORIS standardized the units and loaded data into the data base.
- BORIS extracted data from data base into ASCII files.

#### **9.2.2 Processing Changes**

None.

### **9.3 Calculations**

None.

#### **9.3.1 Special Corrections/Adjustments**

None.

#### **9.3.2 Calculated Variables**

None.

### **9.4 Graphs and Plots**

None.

## **10. Errors**

### **10.1 Sources of Error**

None given.

### **10.2 Quality Assessment**

None given.

#### **10.2.1 Data Validation by Source**

None given.

#### **10.2.2 Confidence Level/Accuracy Judgment**

None given.

#### **10.2.3 Measurement Error for Parameters**

None given.

#### **10.2.4 Additional Quality Assessment**

None given.

#### **10.2.5 Data Validation by Data Center**

BORIS staff loaded the data into the data base and checked for any inconsistencies during loading.

## **11. Notes**

### **11.1 Limitations of the Data**

None given.

### **11.2 Known Problems with the Data**

No problems are known to exist. However, it should be noted that there are significant numbers of nonvascular plants (e.g., green and brown mosses, lichens) present in the fen that were not measured.

### **11.3 Usage Guidance**

The normal caveat of 'use at your own risk' applies. Correspondence with T.J. Arkebauer is encouraged when questions arise or if additional data set details are required.

### **11.4 Other Relevant Information**

Dr. Evan C. Jolitz was responsible for most of the day-to-day coordination of the field measurements, and Ms. Marlene McCloud aided in the LAI measurements. Their assistance is greatly appreciated.

In 1994 an indirect technique (LI-COR LAI-2000 Plant Canopy Analyzer) was used to estimate the total LAI at the fen site. However, for a number of reasons, these values are regarded as unreliable. Those interested in the details are urged to correspond with T.J. Arkebauer (see Section 2.3).

## **12. Application of the Data Set**

These data can be used as estimates of LAI at a typical fen in the boreal forest.

## **13. Future Modifications and Plans**

None.

## **14. Software**

### **14.1 Software Description**

None given.

### **14.2 Software Access**

None given.

## **15. Data Access**

The SSA-Fen 1995 LAI data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### **15.1 Contact Information**

For BOREAS data and documentation please contact:

ORNL DAAC User Services  
Oak Ridge National Laboratory  
P.O. Box 2008 MS-6407  
Oak Ridge, TN 37831-6407  
Phone: (423) 241-3952  
Fax: (423) 574-4665  
E-mail: ornl daac@ornl.gov or ornl@eos.nasa.gov

### **15.2 Data Center Identification**

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics  
<http://www-eosdis.ornl.gov/>.

### **15.3 Procedures for Obtaining Data**

Users may obtain data directly through the ORNL DAAC online search and order system [<http://www-eosdis.ornl.gov/>] and the anonymous FTP site [<ftp://www-eosdis.ornl.gov/data/>] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

### **15.4 Data Center Status/Plans**

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

## **16. Output Products and Availability**

### **16.1 Tape Products**

None.

### **16.2 Film Products**

None.

### **16.3 Other Products**

These data are available on the BOREAS CD-ROM series.

## 17. References

### 17.1 Platform/Sensor/Instrument/Data Processing Documentation

None.

### 17.2 Journal Articles and Study Reports

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

Sellers, P., F. Hall, and K.F. Huemmrich. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. *Bulletin of the American Meteorological Society*. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. *Journal of Geophysical Research* 102(D24): 28,731-28,770.

Suyker, A.E., S.B. Verma, and T.J. Arkebauer. 1997. Season-long measurement of carbon dioxide exchange in a boreal fen. *Journal of Geophysical Research* 102 (D24): 29,021-29,028.

### 17.3 Archive/DBMS Usage Documentation

None.

## 18. Glossary of Terms

None.

## 19. List of Acronyms

ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CD-ROM	- Compact Disk-Read-Only-Memory
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System

GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
IFC	- Intensive Field Campaign
LAI	- Leaf Area Index
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
SSA	- Southern Study Area
TF	- Tower Flux
URL	- Uniform Resource Locator
UTM	- Universal Transverse Mercator

## **20. Document Information**

### **20.1 Document Revision Date of This Document**

Written: 30-Jun-1997

Last Revised: 12-Sep-1999

### **20.2 Document Review Date(s)**

BORIS Review: 19-Apr-1999

Science Review:

### **20.3 Document ID**

### **20.4 Citation**

When using these data, please acknowledge T.J. Arkebauer and E.C. Jolitz and include citations of relevant papers in Section 17.2.

If using data from the BOREAS CD-ROM series, also reference the data as:

Arkebauer, T.J. and S.B. Verma, "Field Micrometeorological Measurements, Process-Level Studies and Modeling of Methane and Carbon Dioxide Fluxes in a Boreal Wetland Ecosystem (SSA-Fen)." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

### **20.5 Document Curator**

### **20.6 Document URL**

# REPORT DOCUMENTATION PAGE

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